ASSESSING SOIL HEALTH

Introduction

What is soil health?

Various definitions exist for “soil heath” but the general consensus is that a healthy soil will have a continued capacity to sustain plant, animal and human ecosystems. It is a dynamic quality that can be affected by land-use, management practices and climactic effects.

For agricultural and horticultural production systems, soil health is a combination of *physical properties* such as soil texture, *chemical properties* such as pH and mineral nutrient content, and *biological properties* including living biomass and mineralisable N. All of these properties are profoundly influenced by the soil organic matter and soil type.

A healthy soil will have good tilth (crumbly, well-structured, dark with organic matter), extensive rooting, optimal pH, sufficient nutrients and be free of contaminants.

Tests

The **Basic Soil Profile (BS)** reports *chemical properties* related to soil quality:

- pH
- Cation exchange capacity (CEC) and plant available nutrients e.g. Phosphorus (P), Potassium (K), Magnesium (Mg), Calcium (Ca) and Sodium (Na)

The **Sulphur(S) profile** reports extractable forms of Sulphur as SO4-S and organic-S, and are important soil fertility measures.

Anion Storage Capacity (ASC) is an inherent soil characteristic and is measure of the soils capacity to store P and S.

The **Organic Soil Profile (OrgSP)** includes some additional tests that allow an assessment of the *biological properties.*

Along with the more sensitive **Hot Water Extractable Carbon (HWEC)** test, a dataset for estimating and monitoring soil quality or health is obtained. The OrgSP suite focuses on the soil organic matter fraction and comprises the following tests:

- organic matter (total carbon)
- anaerobically mineralisable nitrogen (potentially available nitrogen)
- total nitrogen
- carbon:nitrogen ratio
- anaerobically mineralisable nitrogen:total nitrogen ratio

The quantity and nature of organic matter is highly dependent upon farming practices and climatic conditions. Factors known to affect the build up or depletion of soil organic matter are listed below:

Organic Matter Accumulation	**Organic Matter Depletion**
Grass/clover pasture	Bare soil/fallow
Moist summer growing conditions	Summer drought
Direct drill/no tillage	Intensive cultivation
Incorporation of crop residues	Removal or burning crop residues
Controlled Grazing	Overgrazing
Friable soil structure, good root density	Compacted soil, shallow root zone
Moderate N fertiliser application	Excessive N fertiliser applications
Green manure/cover crops	Erosion

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Hot Water Extractable Carbon (HWEC)

While the total organic matter and the C:N ratio (determined from total carbon and total nitrogen) are useful as a guide to soil health and the likely rate of organic matter mineralisation, they are fairly imprecise indicators. Small changes in the quantity and nature of the soil organic matter can substantially affect soil health and fertility, but are not always apparent from the total N and C tests.

A better determinant of soil health would be soil microbial biomass Carbon, but analysis of soil microbial biomass is time-consuming and expensive.

Trials have shown that Hot Water Extractable Carbon (HWEC), the labile fraction of the soil Organic Carbon pool, correlates strongly with soil microbial biomass C. The HWEC test has been offered by Hill Labs since 2017. An estimated Microbial Biomass Carbon (MBC_{est}) will be reported when HWEC is measured, by way of the correlation equation as published by Ghani *et al* (2003):

$$MBC_{est} = HWEC\ (mg/kg) \times 0.13 + 26$$

[Note: This correlation equation applies when the direct fumigation and extraction difference method for MBC is used. It would not be valid for methods that also include a correction factor for the measurement of MBC.]

The HWEC test provides a robust measure of the more labile soil carbon fraction and has been shown to be sensitive to subtle changes in soil quality that occur due to farm management practices and climactic effects.

Researchers have shown the HWEC test to be an indicator that is sensitive to changes due to fertilisation and grazing as well as physical modification to soils e.g. humping/hollowing and flipping. Differences between ecosystems have also been described, whereby HWEC is generally higher in low intensity soil-plant systems than those under intensive usage, following a decreasing pattern for soils: native>drystock>dairy>cropping>market gardens (for the same soil type).

Earthworm eDNA

A new environmental DNA (eDNA) test that provides an indication of the presence of *Aporrectodea caliginosa* (New Zealand's most prominent earthworm species) in soil samples is offered from July 2024.

Earthworms are a crucial component of soil biology, and abundant earthworm populations are recognised as an indicator of healthy soil. Previously, methods for identifying earthworm populations were labour-intensive, requiring going out to a field and taking a spade-square down to the depth of the spade, taking that soil, breaking it up and counting the earthworms.

Our new Earthworm eDNA test (EWeDNAp) contributes to building a holistic understanding of soil health. Molecular technology, in the form of quantitative real-time PCR (qPCR) is used to identify the DNA trace of *A. Caliginosa*. Please refer to the Hill Labs Technical Note – Soil Test for Earthworm eDNA for more information on this test.

It is important that soil samples are submitted to the laboratory as soon as possible after collection, as the eDNA degrades rapidly in fresh soil samples. The eDNA is stable once the soil has been dried and ground in the laboratory. If samples cannot be put on the courier the same day of sampling, then they should be refrigerated. Avoid sending soil samples for this test on a Friday. This test is likely most useful when earthworms are active, so testing in very dry periods is not recommended.

Soil Texture

A laboratory test for soil texture (%sand, silt, clay) on the inorganic soil fraction is available on request. The laboratory uses a sedimentation hydrometer method, and has limited capacity for this two-day procedure. This may be a useful test for soil texture classification (where it is not already known) and can help with evaluation of farm management practices such as irrigation, agrichemical or effluent application, stocking rate and cultivation.

Conclusion

A package of related tests is offered, to better assess the overall health of a soil. Most of the tests have been offered for many years, but the Hot Water Extractable Carbon is a new service as from 2017. Refer also to related Technical Notes: Laboratory Tests for Soil Carbon; Organic Soil Profile and Measurement of Soil Texture for more detail and the references supporting these test methods. By default, some of these tests are now measured using Near Infra-Red Spectroscopy (NIRS), with qualifying criteria applied for each test. Where reference wet chemistry methods are requested, additional fees will usually apply. The laboratory report method-text table describes which method has been used for every sample.
The new Soil Health package has been created to make it easy to select the most applicable laboratory tests for monitoring soil health.
Some additional tests that help evaluate soil health are also described in this services offered note.

SERVICES OFFERED

Profile or Test Name	Test Code	Includes	List price (excl GST)
Soil Health package	SHealthp (includes BS, S, ASC, OrgSP, HWEC)	pH, Olsen P, Exchangeable Cations (Ca, Mg, K, Na), Cation Exchange Capacity, %Base Saturation, Volume Weight, Sulphate-Sulphur, Extractable Organic Sulphur, Anion Storage Capacity, Organic Matter (from Total Carbon), Total Nitrogen, Potentially Available N (AMN), CN ratio and Hot Water Extractable Carbon plus estimated Microbial Biomass Carbon	$162
Additional tests (prep fees will apply if requested by themselves)			
Earthworm eDNA	EWeDNAp	Earthworm eDNA (as *A.caliginosa)* in soil by qPCR	$95
Soil texture	STexture	%sand, %silt,%clay in the inorganic soil fraction	$189
Others	tCd	Total Recoverable Cadmium	$31
	tCu	Total Recoverable Copper	$23

Contact

Please contact an Agriculture Client Services Manager (ag.csm@hill-labs.co.nz) for further information or visit our website www.hill-labs.co.nz to view the resources page (including Technical Notes and references) or to order sampling supplies.